(12) UK Patent Application (19) GB (11) 2 056 556 A

(21) Application No 8021599
(22) Date of filing 2 Jul 1980
(30) Priority data
(31) 2932133
(32) 8 Aug 1979
(33) Fed Rep of Germany (DE)
(43) Application published 18 Mar 1981
(51) INT CL³ F02D 17/02 37/00
(52) Domestic classification F1B B102 B120 B212 BC BD
(56) Documents cited None
(58) Field of search F1B

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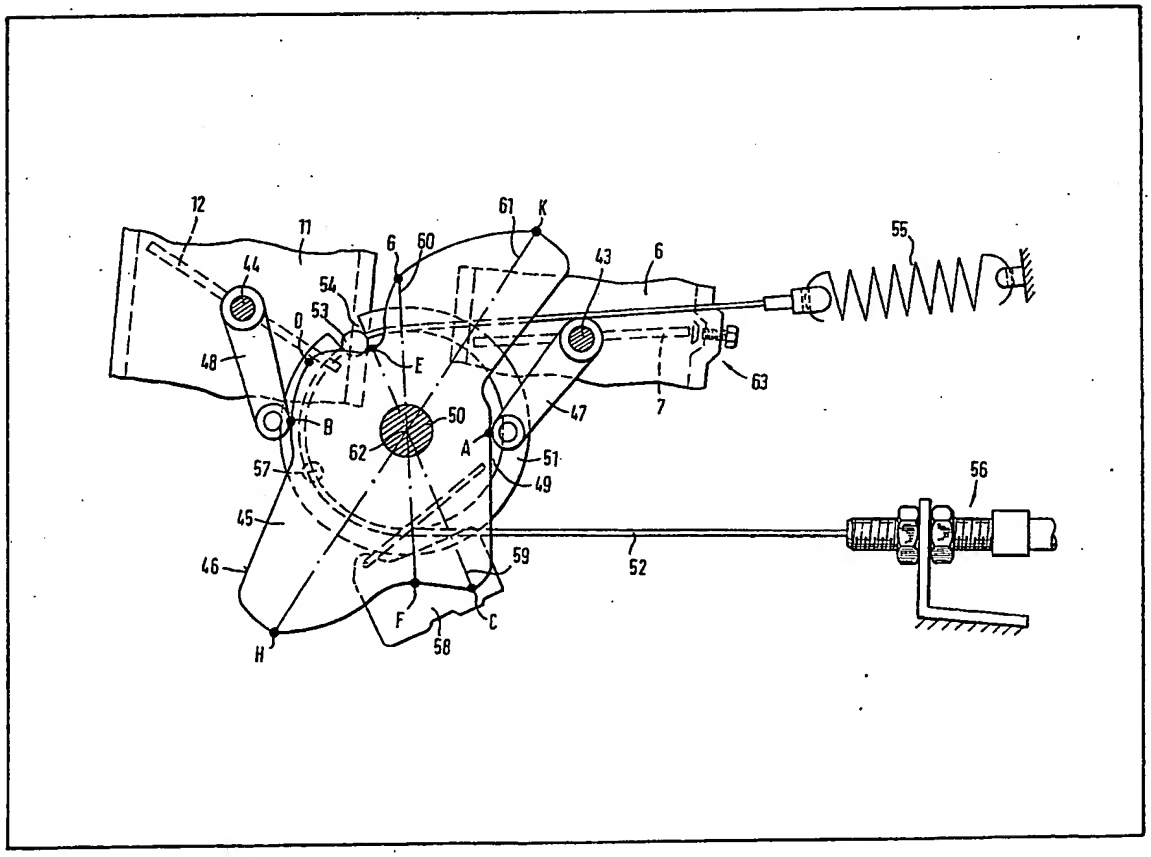
(54) Control of air-fuel mixture supply in a multi-cylinder internal combustion engine

(57) Air-fuel mixture is supplied to a first group of engine cylinders through the load range, whereas a second group of cylinders is supplied with air only up to a partial load and thereafter with an air-fuel mixture. Each group of cylinders has a respective throttle valve 7, 12 and associated control levers 47, 48 which co-operate with the cam surface 46 of a cam disc 45 to achieve the desired supply of air-fuel mixture, or air, under all operating conditions of the engine. The cam surface provides a particular opening schedule for the throttle valves and a cam stud 57 operates a switch 58 to initiate operation of fuel fuel injectors supplying the second group of cylinders.



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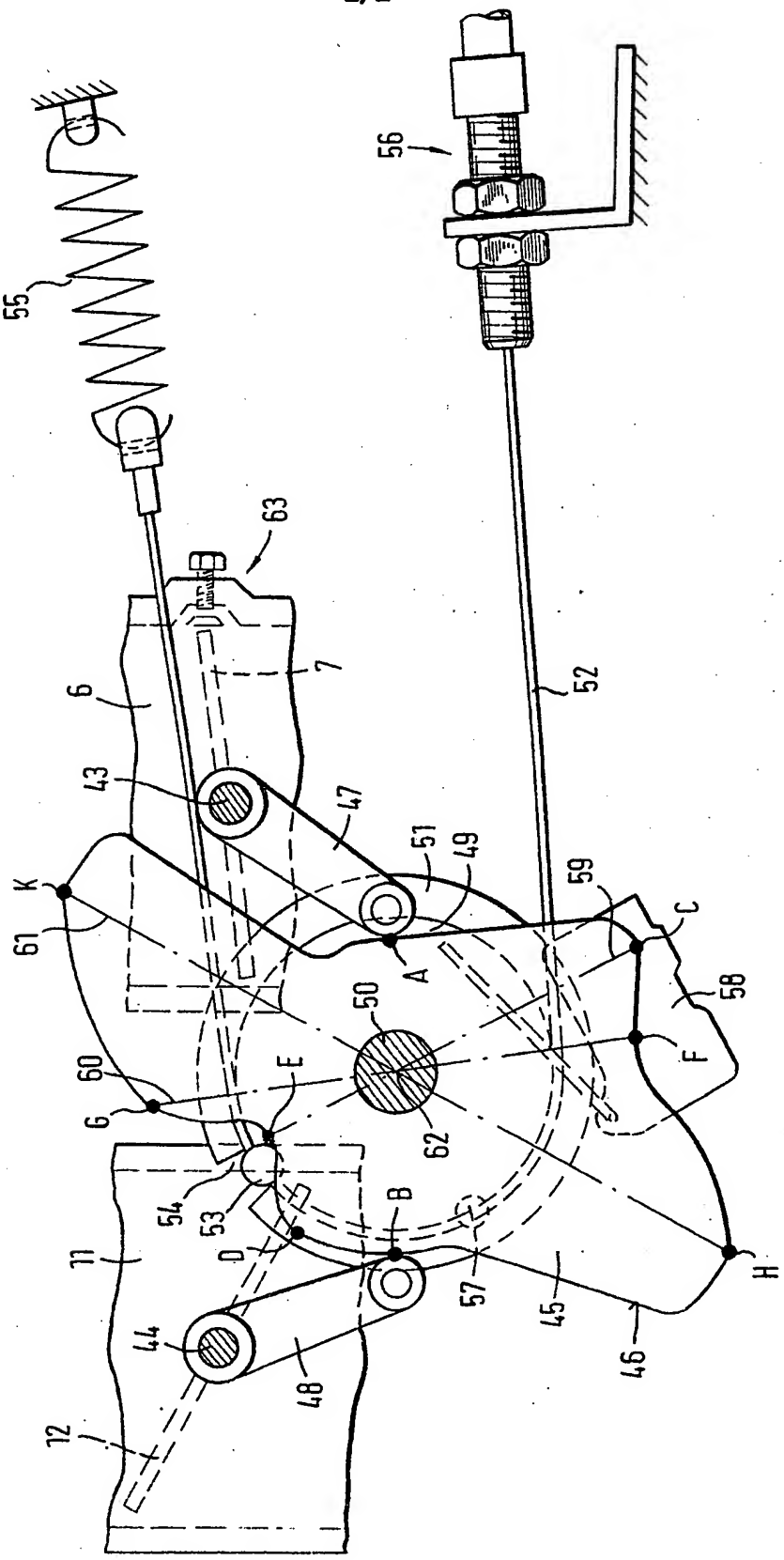
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SPECIFICATION

Multi-cylinder internal combustion engine, in particular for motor vehicles

The invention relates to a multi-cylinder internal combustion engine as disclosed in British Patent Application No. 8005227, having two air-fuel mixture supply means associated, respectively, with two different groups of cylinders having electromagnetically actuable fuel injection valves, wherein air-fuel mixture is supplied to the first group of cylinders in all ranges of operation of the internal combustion engine and wherein dependent upon the position of the accelerator pedal the second group of cylinders is supplied with air from idling operation to the end of a predetermined partial load range of the internal combustion engine, and with air-fuel mixture from the end of the predetermined partial load range to full load operation of the internal combustion engine, and each group of cylinders has a throttle valve positioned in its intake passage, which throttle valve is variable in position by movement of the accelerator pedal.

The object of the present invention is to provide a cam disc by means of which the supply of air-fuel or air, respectively, to the groups of cylinders of the internal combustion engine is effected in the manner illustrated with reference to the control graph shown in Fig. 2 of the above-mentioned Application No. 8005227.

According to the invention, the supply of the air-fuel mixture or air, respectively, is controlled by control levers fixedly mounted, respectively, on throttle valve shafts which co-operate with the cam surface of a cam disc, said cam disc being formed as follows:

(a) During idling operation of the internal combustion engine the control lever of the first group of cylinders lies against a control point (A) of the cam surface whereby the associated throttle valve is closed and the first group of cylinders is supplied with air for the idling air-fuel mixture by way of an idling adjustment device, and the control lever of the second group of cylinders lies against a control point (B) of the cam surface, whereby the associated throttle is slightly open, so that the second group of cylinders is fed with air with the fuel supply shut off;

(b) At the end of a predetermined partial load range of the internal combustion engine, on the one hand the control lever of the first group of cylinders lies against a control point (C) of the cam surface, the quantity of air-fuel mixture fed to the first group of cylinders being continuously increased up to this control point (C), and on the other hand the control lever of the second group of cylinders lies first against a control point (D) of the cam surface which represents the end of a first part of the predetermined partial load range, and up to which the quantity of air supplied to the second group of cylinders is increased continuously, and thereafter the last-mentioned control lever lies against a control point (E) which represents the end of the predetermined partial load range, and up to which the quantity of air is continuously reduced to approximately zero;

(c) The cam disc is provided with a control member and, when the control points (C and E) are reached which are arranged on a common control plane extending through the axis of rotation of the cam disc, the control member actuates simultaneously a switch by which the fuel injection nozzles for the second group of cylinders are rendered operative;

(d) Above the predetermined partial load range the control lever of the first group of cylinders lies against a control point (F) of the cam surface and the control lever of the second group of cylinders lies against a control point (G) which is arranged on a second control plane extending through the axis of rotation of the cam disc, wherein up to these control points the quantity of air-fuel mixture supplied to the first group of cylinders is continuously reduced for a period, and the quantity of air-fuel mixture supplied to the second group of cylinders is continuously increased for a period so that the quantities of air-fuel mixture for the two groups of cylinders are of equal magnitude at the control points (F and G) and the continuous reduction of the quantity of fuel-air mixture supplied to the first group of cylinders occurs to a lower degree than the continuous increase of the quantity of fuel-air mixture supplied to the second group of cylinders;

(e) In the full-load range of the internal combustion engine the control lever of the first group of cylinders lies against a control point (H) of the cam surface and the control lever of the second group of cylinders lies against a control point (K) of the cam surface, the control points (H) and (K) being arranged on a third common control plane extending through the axis of rotation of the cam disc, wherein the quantities of fuel-air mixture for the two groups of cylinders are increased continuously to the same extent.

The drawing illustrates a constructional form of the present invention by way of example.

The drawing shows portions of intake passages 6 and 11, connected respectively, to first and second groups of cylinders (not shown). The passages have, respectively, throttle valves 7 and 12 fixedly mounted on throttle shafts 43 and 44, the pivotal movement of the throttle valves being controlled by a cam disc 45. The cam disc has a cam surface 46 slidably engaged by the free end of a swing lever 47 which is fixedly connected to the throttle shaft 43, and by the free end of a swing lever 48 which is fixedly connected to the throttle shaft 44.

The cam disc 45 together with a guide disc 49 is fixedly mounted on a horizontal shaft 50 which extends approximately in the centre between the intake passages 6 and 11. The guide disc has a circumferentially extending groove 51 in which an operating cable 52 is disposed. The cable 52 is fixedly secured to a roller 53 which is located, in order to prevent relative movement in a radial slot 54 extending inwardly from the periphery of the guide disc 49. One end of the cable 52 is connected to a return spring 55 and the other end thereof is disposed in an adjustment device 56 and connected to the accelerator pedal (not shown).

The cam disc 45 is provided with a control stud 57 which co-operates with an electric switch 58. Control

points on the cam surface 46 of the cam disc are denoted by A, B, C, D, E, F, G, H and K, the control points C and E being arranged on a common control plane 59, the control points F and G being arranged on a common control plane 60 and the control points H and K being arranged on a common control plane 61. The control planes 59, 60 and 61 extend through the axis of rotation 62 of the cam disc 45. An idling speed adjustment device is denoted by 63.

During idling operation of the internal combustion engine the control lever 47 of the first group of cylinders (not shown) lies against the control point A of the cam surface 46, whereby the throttle valve 7 is closed and the first group of cylinders is supplied with air for the idling operation fuel-air mixture by way of the idling adjustment device, and the control lever 48 of the second group of cylinders (not shown) lies against a control point B of the cam surface 46 whereby the throttle valve 12 is slightly open, so that air is supplied to the second group of cylinders with the fuel supply shut off.

From idling operation to the end of a predetermined partial load range of the internal combustion engine, on the one hand the cam surface 46 of the cam disc 45 slides over the end of the control lever 47 of the first group of cylinders as far as a control point C, whereby the quantity of fuel-air mixture supplied to the first group of cylinders is continuously increased, and on the other hand the cam surface 46 of the cam disc 45 slides over the end of the control lever 48 of the second group of cylinders first, as far as the control point D which represents the end of a first part of the predetermined partial load range and up to which the quantity of air supplied to the second group of cylinders is continuously increased, and thereafter as far as the control point E which represents the end of the predetermined partial load range and up to which the quantity of air is continuously reduced down to approximately zero.

When the control points C and E are reached which are arranged on a common control plane 59 the switch 58 for the supply of fuel to the second group of cylinders is actuated simultaneously by the control stud 57 arranged on the cam disc 45. In a constructional form of the invention given by way of example, this is attained by switching on electromagnetic injection valves, such as are employed in the fuel injection installations L-Jetronic (Registered Trade Mark) of the Firm Bosch (Registered Trade Mark).

From the control point C onwards, the cam surface 46 of the cam disc 45 slides over the end of the control lever 47 of the first group of cylinders as far as the control point F on the one hand, and on the other hand the cam surface 46 of the cam disc 45 slides over the end of the control lever 48 of the second group of cylinders as far as the control point G which is arranged on the common control plane 60, whereby the quantity of fuel-air mixture supplied to the first group of cylinders is continuously reduced for a period and the quantity of fuel-air mixture supplied to the second group of cylinders is continuously increased for a period so that the quantities of fuel-air mixture for the two groups of cylinders are of the same magnitude at the control points F and G and the continuous reduction of the quantity of fuel-air mixture supplied to the first group of cylinders is to a lower degree than the continuous increase of the quantity of fuel-air mixture supplied to the second group of cylinders.

From the control point F onwards, on the one hand the cam surfaces 46 of the cam disc 45 slides over the end of the control lever 47 of the first group of cylinders as far as the control point H, and on the other hand the cam surface 46 of the cam disc 45 slides over the end of the control lever 48 of the second group of cylinders as far as the control point K which together with the control point H is arranged on the common control plane 61 and which in the same way as the control point H indicates the full load of the internal combustion engine, the quantities of the fuel-air mixture for the two groups of cylinders being continuously increased to the same extent in this case.

CLAIMS

1. A multi-cylinder internal combustion engine comprising two air-fuel mixture supply means associated, respectively, with two different groups of cylinders which have electro-magnetically actuable fuel injection valves and wherein air-fuel mixture is supplied to the first group of cylinders in all operative ranges of the internal combustion engine and the second group of cylinders is fed with air dependent upon the position of the accelerator pedal from idling operation to the end of a predetermined partial load range of the internal combustion engine and is fed with fuel-air mixture from the end of the predetermined partial load range to full load of the internal combustion engine, each group of cylinders having a throttle valve positioned in its intake passage, the position of the throttle valve being variable by the accelerator pedal, characterised in that the supply of air-fuel mixture or air, respectively, is controlled by control levers fixedly mounted, respectively, on throttle valve shafts which co-operate with the cam surface of a cam disc, said cam disc being formed as follows:

(a) During idling operation of the internal combustion engine the control lever of the first group of cylinders lies against a control point (A) of the cam surface whereby the associated throttle valve is closed and the first group of cylinders is supplied with air for the idling air-fuel mixture by way of an idling adjustment device, and the control lever of the second group of cylinders lies against a control point (B) of the cam surface, whereby the associated throttle is slightly open, so that the second group of cylinders is fed with air with the fuel supply shut off;

(b) At the end of a predetermined partial load range of the internal combustion engine, on the one hand the control lever of the first group of cylinders lies against a control point (C) of the cam surface, the quantity of air-fuel mixture fed to the first group of cylinders being continuously increased up to this control point (C), and on the other hand the control lever of the second group of cylinders lies first against a control point (D) of the cam surface which represents the end of a first part of the predetermined partial load range, and up to which the quan-

tity of air supplied to the second group of cylinders is increased continuously, and thereafter the last-mentioned control lever lies against a control point (E) which represents the end of the predetermined partial load range, and up to which the quantity of air is continuously reduced to approximately zero;

(c) The cam disc is provided with a control member and, when the control points (C and E) are reached which are arranged on a common control plane extending through the axis of rotation of the cam disc, the control member actuates simultaneously a switch by which the fuel injection nozzles for the second group of cylinders are rendered operative;

(d) Above the predetermined partial load range the control lever of the first group of cylinders lies against a control point (F) of the cam surface and the control lever of the second group of cylinders lies against a control point (G) which is arranged on a second control plane extending through the axis of rotation of the cam disc, wherein up to these control points the quantity of air-fuel mixture supplied to the first group of cylinders is continuously reduced for a period, and the quantity of air-fuel mixture supplied to the second group of cylinders is continuously increased for a period so that the quantities of air-fuel mixture for the two groups of cylinders are of equal magnitude at the control points (F and G) and the continuous reduction of the quantity of fuel-air mixture supplied to the first group of cylinders occurs to a lower degree than the continuous increase of the quantity of fuel-air mixture supplied to the second group of cylinders;

(e) In the full-load range of the internal combustion engine the control lever of the first group of cylinders lies against a control point (H) of the cam surface and the control lever of the secondary group of cylinders lies against a control point (K) of the cam surface, the control points (H) and (K) being arranged on a third common control plane extending through the axis of rotation of the cam disc, wherein the quantities of fuel-air mixture for the two groups of cylinders are increased continuously to the same extent.

2. A multi-cylinder internal combustion engine substantially as described with reference to, and as illustrated in, the accompanying drawing.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1981.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.